Work-Energy

eg.

1. You pull a 45kg bale of hay with 450N of force at 28º to the horizontal over 4.0 m. If the force of friction is 250N determine work done by:

a) you

$W = Fd\cos\theta = 450N(4.0m)\cos 28°$

$= 1600 J$

a) friction

$W = Fd = -250N \times 4.0m$

$= (-)1.0 \times 10^3 J$ Not a Vector

work is negative when F is opposite d
loss of energy

b) net force

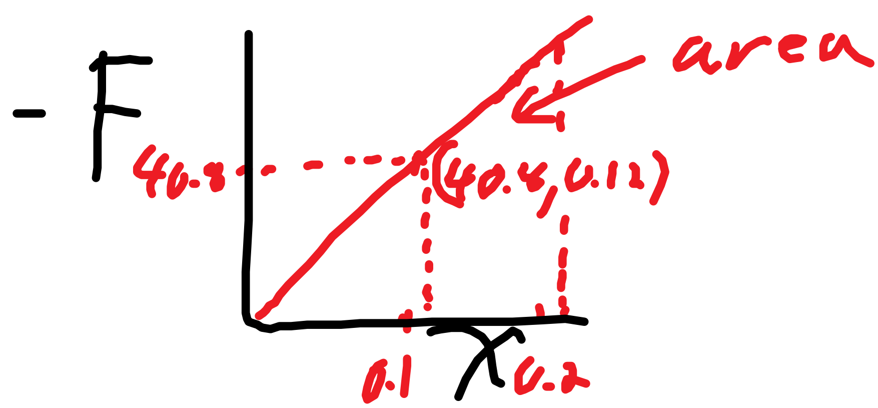
W=Fd = (450 cos28 - 250)x4 = 590J

or W by applied force - W by friction

c) normal force W=0 F perpendicular to d
d) gravity W=0

1. A spring has a length of 20.0 cm when not extended. If you hang a 500. g mass on it, it extends to 32.0cm.
what is the elastic constant, k?
$F_{elastic}$=-kx
k = -F/x = - (0.50kg x 9.8N/kg)/(-0.12m)
k= 40.8N/m

graph $F_{elastic}$ vs x

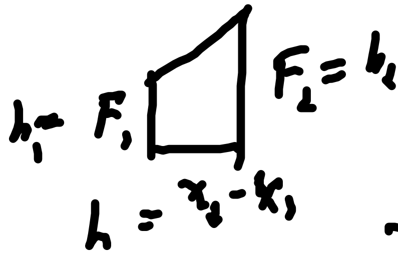


how much work is done pulling the 500g mass down another 10.0 cm (from length 32.0cm to 42.0cm)
W= area under the F-x graph

(=integral of the F - x function)

$$\int_{x_1}^{x_2} F\,dx = \int kx\,dx = \frac{1}{2}kx_2^2 - \frac{1}{2}kx_1^2$$

or area of trapezoid $= \frac{1}{2}(base_1 + base_2)\,h$



$$= \frac{1}{2}(F_2 + F_1)(x_2 - x_1)$$

$$= \frac{1}{2}(kx_2 + kx_1)(x_2 - x_1)$$

$$= \frac{1}{2}(kx_2^2 - \cancel{kx_2x_1} + \cancel{kx_2x_1} - kx_1^2)$$

$$= \frac{1}{2}kx_2^2 - \frac{1}{2}kx_1^2$$

Elastic Energy $E_{elastic}=1/2kx^2$ relative to Energy = 0 when x = 0 so our constant =0

$=1/2\ (40.8N/m)[(0.22m)^2-(0.12m)^2]$

= 0.5x40.8x(0.22^2-0.12^2)=0.6936

0.694J of energy is required

c) if you let go after c, what is the

acceleration of the 500g mass?

$a=F_{net}/m = (F_{elastic}-F_g)/m$
$= (40.8N/m \times 0.22m - 0.5kg \times 9.80N/kg)/0.5kg$
$= (40.8 \times 0.22-0.5 \times 9.8)/0.5=8.152$
$8.15m/s^2$

Other forms of energy
kinetic energy, E_k
$E_k=1/2mv^2$
derived from W=Fd F=ma and $2ad=v_f^2-v_i^2$
$= mad = m (v_f^2-v_i^2)/2 = 1/2 mv_f^2 - 1/2 mv_i^2$
W=change in energy
work done by the net force = change in kinetic energy
so area under a Fnet - d graph is change in kinetic energy

Gravitational Energy, E_g
$E_g=mgh$ if g is constant (near Earth)
derived from $W_g=F_gd = mg\Delta h$
set our reference energy $E_g=0$ when h=0

eg. You bungee jump from 111m using a

bungee cord that is 10.0m long. If you have a mass of 85.0kg, height 2.0m(centre of mass is 1.0m)

a) what is your initial gravitational energy?
b) what is your speed when the cord is about to start stretching?
c) what elastic constant of the bungee cord will just stop you from hitting the water?
d) what is your acceleration at the bottom point?
e) what is the stretch of the bungee cord at equilibrium point(where you stop bouncing)?
f) how much energy was lost in frictional forces when you are at equilibrium point?